

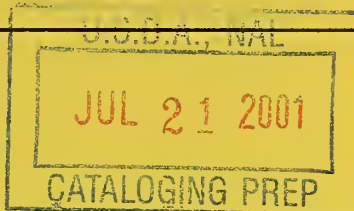
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Technical Information From FSIS

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Kitchen Thermometers

One of the critical factors in controlling pathogens in food is controlling temperature. Disease-causing microorganisms such as bacteria, viruses, and parasites grow very slowly at low temperatures, multiply rapidly in mid-range temperatures, and are killed at high temperatures. For safety, perishable foods must be held at proper cold temperatures to inhibit bacterial growth or cooked to temperatures high enough to kill harmful microorganisms. It is essential to use a food thermometer when cooking meat, poultry, and egg products to prevent undercooking, and consequently, prevent foodborne illness.

Why Use a Food Thermometer?

Using a food thermometer is the only reliable way to ensure safety and to determine the "doneness" of meat, poultry, and egg products. To be safe, these foods must be cooked to an internal temperature high enough to destroy any harmful microorganisms that may be in the food.

"Doneness" refers to when a food is cooked to a desired state and indicates the sensory aspects of foods such as texture, appearance, and juiciness. Unlike the temperatures required for safety, these sensory aspects are subjective.

Color is Not a Reliable Indicator

Many food handlers believe that visible indicators, such as color changes, can be used to determine if foods are cooked to a point where pathogens are killed. However, recent research has shown that color and texture indicators are unreliable. For example, ground beef may turn brown before it reaches a temperature where pathogens are destroyed. A consumer preparing hamburger patties and using the brown color as an indicator of "doneness" is taking a chance that pathogenic

microorganisms may survive. A hamburger cooked to 160 °F, regardless of color, is safe.

Safety Versus Doneness

The temperature at which different pathogenic microorganisms are destroyed varies, as does the "doneness" temperature for different meat and poultry. A roast or steak that is not pierced in any way during processing or preparation and reaches an internal temperature of 145 °F is safe to eat. A consumer looking for a visual sign of "doneness" might continue cooking it until it is overcooked and dry. However, a consumer using a food thermometer to check for "doneness" can feel assured the food has reached a safe temperature and is not overcooked.

Likewise, poultry should reach at least 160 °F throughout for safety. However, at this temperature, the meat has not reached a traditional "done" texture and color. For this reason, most consumers prefer to cook it longer (to a higher temperature).

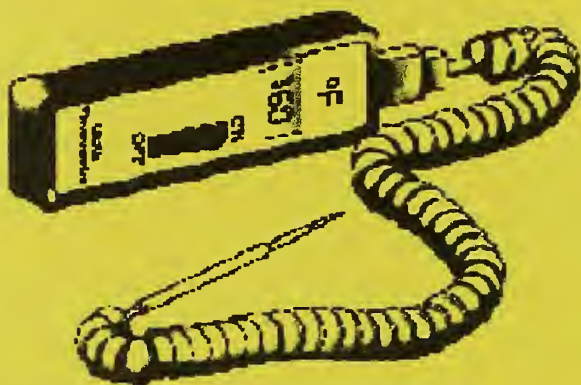
A food thermometer should also be used to ensure that cooked foods are held at safe temperatures until served — 40 °F or below, or 140 °F and above.

Types of Thermometers

Food thermometers come in several types and styles, and vary in level of technology and price.

Digital Food Thermometers

Thermocouple: Of all food thermometers, thermocouple thermometers reach and display the final temperature the fastest – within 2 to 5 seconds. The temperature is indicated on a digital display.



A thermocouple measures temperature at the junction of two fine wires located in the tip of the probe. Thermocouples used in scientific laboratories have very thin probes, similar to hypodermic needles, while others may have a thickness of 1/16 of an inch.

Since thermocouple thermometers respond so rapidly, the temperature can be quickly checked in a number of locations to ensure that the food is thoroughly cooked. This is especially useful for cooking large foods, such as roasts or turkeys, when checking the temperature in more than one place is advised. The thin probe of the thermocouple also enables it to accurately read the temperature of thin foods such as hamburger patties, pork chops, and chicken breasts.

Thermocouples are not designed to remain in the food while it's cooking. They should be used near the end of the estimated cooking time to check for final cooking temperatures. To prevent overcooking, check the temperature before the food is expected to finish cooking.

Thermocouples can be calibrated for accuracy.

Thermistors: Thermistor-style food thermometers use a resistor (a ceramic semiconductor bonded in the tip with temperature-sensitive epoxy) to measure temperature. The thickness of the probe is approximately 1/8 of an inch and takes roughly 10 seconds to register the temperature on the digital display. Since the semiconductor is in the tip, thermistors can measure temperature in thin foods, as well as thick foods. Because the center of a food is usually cooler than the outer surface, place the tip in the center of the thickest part of the food.

Thermistors are not designed to remain in the food while it's cooking. They should be used near the end of the estimated cooking time to check for final cooking temperatures. To prevent overcooking, check the temperature before the food is expected to finish cooking.

Not all thermistors can be calibrated. Check the manufacturer's instructions.



Oven Cord Thermometers: This food thermometer allows the cook to check the temperature of food in the oven without opening the oven door. A base unit with a digital screen is attached to a thermistor-type food thermometer probe by a long metal cord. The probe is inserted into the food, and the cord extends from the oven to the base unit. The base can be placed on the counter or attached to the stovetop or oven door by a magnet. The thermometer is programmed for the desired temperature and beeps when it is reached. While designed for use in ovens, these thermometers can also be used to check foods cooking on the stove. Oven cord thermometers cannot be calibrated.

Thermometer Fork Combination: This utensil combines a cooking fork with a food thermometer. A temperature-sensing device is embedded in one of the tines of the fork. There are several different brands and styles of thermometer forks on the market; some using thermocouples and some using thermistors. The food temperature is indicated on a digital display or by indicator lights on the handle within 2 to 10 seconds (depending on the type). These lights will tell if the food has reached rare, medium, well done, etc. Particularly useful for grilling, the thermometer fork will accurately measure the internal temperature of even the thinnest foods. The thermometer fork should be used to check the temperature of a food towards the end of the estimated cooking time. Thermometer forks are not designed remain in a food while in the oven or on the grill. Thermometer forks cannot be calibrated.



Dial Food Thermometers

Bimetallic-coil Thermometers: These thermometers contain a coil in the probe made of two different metals that are bonded together. The two metals have different rates of expansion. The coil, which is connected to the temperature indicator, expands when heated. This food thermometer senses temperature from its tip and up the stem for 2 to 2 1/2 inches. The resulting temperature is an average of the temperatures along the sensing area. These food thermometers have a dial display and are available as “oven-safe” and “instant-read.”

- **“Oven-safe” Bimetallic-coil**

Thermometers: This food thermometer is designed to remain in the food while it is cooking in the oven, and is generally used for large items such as a roast or turkey. This food thermometer is convenient because it constantly shows the temperature of the food while it is cooking. However, if not left in the food while cooking, they can take as long as 1 to 2 minutes to register the correct temperature.

The bimetal food thermometer can accurately measure the temperature of relatively thick foods (such as beef roasts) or deep foods (foods in a stockpot). Because the temperature-sensing coil on the stem is between 2 to 2 1/2 inches long and the stem is relatively thick, it is not appropriate to measure the temperature of any food less than 3 inches thick.

There is concern that because heat conducts along the stem's metal surface faster than through the food, the area of the food in contact with the thermometer tip will be hotter than the area a short distance to the side (the “potato nail effect”). To remedy this, the temperature should be taken in a second, and even third area, to verify the temperature of the food. Each time the thermometer is inserted into the food, let the thermometer equilibrate (come to temperature) at least 1 minute before reading the temperature.

Some models can be calibrated. Check the manufacturer's instructions.



- **“Instant Read” Bimetallic-coil**

Thermometers: This food thermometer quickly measures the temperature of a food in about 15 to 20 seconds. It is not designed to remain in the food while it is cooking in the oven, but should be used near the end of the estimated cooking time to check for final cooking temperatures. To prevent overcooking, check the temperature before the food is expected to finish cooking.

For accurate temperature measurement, the probe of the bimetallic-coil thermometer must be inserted the full length of the sensing area (usually 2 to 3 inches). If measuring the temperature of a thin food, such as a hamburger patty or boneless chicken breast, the probe should be inserted through the side of the food so that the entire sensing area is positioned through the center of the food. Some models can be calibrated. Check the manufacturer’s instructions.



Single-Use Temperature Indicators

One of the most recent developments in the retail food market is the emergence of disposable temperature indicators. Several brands are available, and all make quick work of determining if a food has reached its final temperature. These temperature sensors are designed for specific temperature ranges, for example, 160 –170 °F. It is important that the sensors be used only with foods for which they are intended. Read the package directions to ensure that the temperature the sensor will reach is consistent with the safe temperatures listed in this publication.

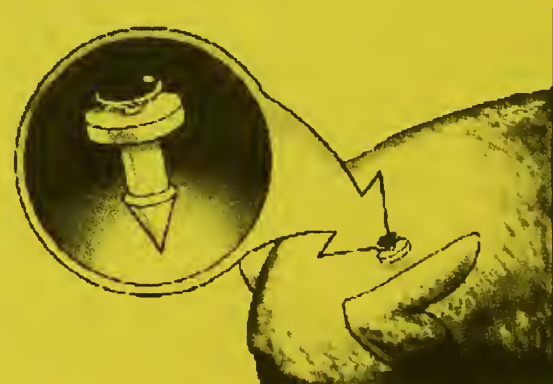
The sensors are made from special temperature-sensitive materials. The sensor is inserted into a food. When the food reaches the proper temperature, the sensor changes

color. They are designed to be used only once. However, if the desired temperature has not been reached, they can be reinserted until the temperature is reached. These sensors cannot be left in a food while it cooking. They should be used near the end of the estimated cooking time. To prevent overcooking, check the temperature before the food is expected to finish cooking.

Disposable temperature indicators are made from materials approved by the FDA for contact with food.

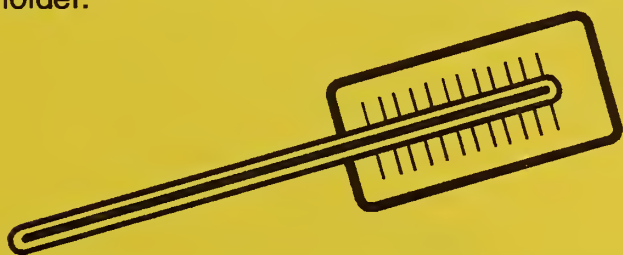


Pop-Up Timers: Commonly used in turkeys and roasting chickens since 1965, the “pop-up” temperature device is constructed from a food-approved nylon. The inside contains a stainless steel spring and firing material. The firing material is made of an organic salt compound or an alloy of metals commonly used in other thermo-sensing devices. The tip of the stem is imbedded in the firing material until it melts, releasing the stem, which is then “popped up” by means of the spring. This indicates that the food has reached the final temperature for safety and doneness. Pop-up timers are reliable within 1 to 2 °F if accurately placed in a food; however, checking the temperature of other parts of the food with a conventional food thermometer is recommended.

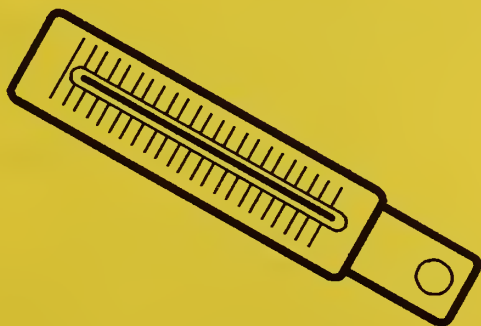


Other Types of Food Thermometers

Liquid-filled Thermometers: Also called “spirit-filled” or “liquid in glass” thermometers, these thermometers are the oldest kind of food thermometer used in home kitchens. They have either metal or glass stems. As the internal temperature of the food increases, the colored liquid inside the stem expands and rises to indicate the temperature on a scale. Heat conduction in the metal stems can cause false high readings. They are designed to remain in the food while it is cooking. They should be inserted at least 2 inches deep in the thickest part of the food, and are, therefore, not appropriate for thin foods. Some liquid-filled thermometers can be calibrated by carefully moving the glass stem within the holder.



Candy/Jelly/Deep Fry Thermometers: These thermometers will measure temperatures ranging from 100 to 400 °F. They are used to measure the extra-high temperatures required of candy and jelly making, as well as frying with hot oil.



Appliance Thermometers

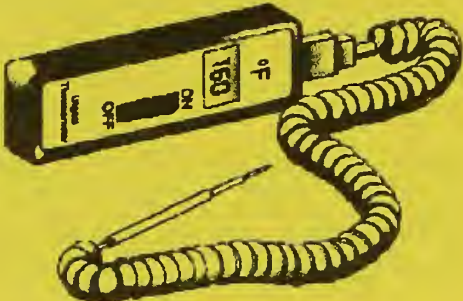


Refrigerator/Freezer Thermometers: For safety, it is important to verify the temperature of refrigerators and freezers. Refrigerators should maintain a temperature no higher than 40 °F. Frozen food will hold its top quality for the longest possible time when the freezer maintains 0 °F. An appliance thermometer can be kept in the refrigerator and freezer to monitor the temperature. This can be critical in the event of a power outage. When the power goes back on, if the refrigerator is 40 °F or colder, and the freezer is still colder than 40 °F, the food is safe. These bimetallic-coil thermometers are specially designed to provide accuracy at cold temperatures.



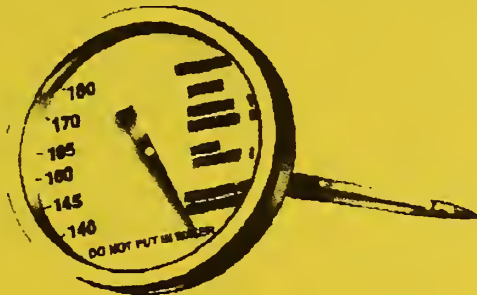

Oven Thermometers: An oven thermometer can be left in the oven to verify that the oven is heating to the desired temperatures. These bimetallic-coil thermometers can measure temperatures from 100 to 600 °F.




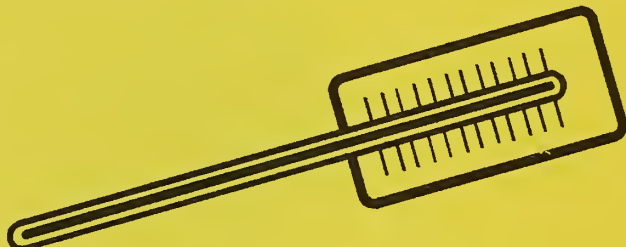
Food Thermometers

Digital Thermometers			
Types	Speed	Placement	Usage Considerations
Thermocouple 	2–5 seconds	1/4" or deeper in the food, as needed	<ul style="list-style-type: none"> • Gives fastest reading • Good for measuring temperatures of thick and thin foods • Not designed to remain in food while it's cooking • Check internal temperature of food near the end of cooking time • Can be calibrated • More costly; may be difficult for consumers to find in stores
Thermistor 	10 seconds	At least 1/2" deep in the food	<ul style="list-style-type: none"> • Gives fast reading • Can measure temperature in thin and thick foods • Not designed to remain in food while it's cooking • Check internal temperature of food near the end of cooking time • Some models can be calibrated; check manufacturer's instructions • Available in "kitchen" stores
Oven Cord Thermometer	10 seconds	At least 1/2" deep in the food	<ul style="list-style-type: none"> • Can be used in most foods • Can also be used outside the oven • Designed to remain in the food while it is cooking in oven or in covered pot • Base unit sits on stovetop or counter • Cannot be calibrated
Thermometer Fork Combination 	2–10 seconds	At least 1/4" in the thickest part of food	<ul style="list-style-type: none"> • Can be used in most foods • Not designed to remain in food while it is cooking • Sensor in tine of fork must be fully inserted • Check internal temperature of food near the end of cooking time • Cannot be calibrated • Convenient for grilling

Food Thermometers (con't)

Dial Thermometers			
Types	Speed	Placement	Usage Considerations
Oven-Safe, Bimetal	1–2 minutes	2–2 1/2" deep in the thickest part of the food	<ul style="list-style-type: none">• Can be used in roasts, casseroles, and soups• Not appropriate for thin foods• Can remain in food while it's cooking• Heat conduction of metal stem can cause false high reading• Some models can be calibrated; check manufacturer's instructions
			
Instant-Read, Bimetal	15–20 seconds	2–2 1/2" deep in the thickest part of the food	<ul style="list-style-type: none">• Can be used in roasts, casseroles, and soups• Temperature is averaged along probe, from tip to 2–3" up the stem• Cannot measure thin foods unless inserted sideways• Not designed to remain in food while it is cooking• Use to check the internal temperature of a food at the end of cooking time• Some models can be calibrated; check manufacturer's instructions• Readily available in stores
			

Food Thermometers (con't)

Other			
Types	Speed	Placement	Usage Considerations
Single-Use Temperature Indicators	5–10 seconds	Approx. 1/2" deep (follow manufacturer's directions)	<ul style="list-style-type: none">• Designed to be used only once• Designed for specific temperature ranges• Should only be used with food for which they are intended• Temperature-sensitive material changes color when the desired temperature is reached
			
Liquid-Filled (glass or metal stem)	1–2 minutes	At least 2" deep in the thickest part of the food	<ul style="list-style-type: none">• Used in roasts, casseroles, and soups• Can remain in food while it's cooking• Cannot measure thin foods• Some can be calibrated; check manufacturer's instructions• Possible breakage of glass stem while in food• Heat conduction of metal stem can cause false high reading
			

Doneness and Safety

Most pathogens are destroyed between 140 and 160 °F. However, for best quality, meat and poultry require various temperatures for “doneness.”

Recommended Internal Temperatures*

Food	°F
Ground Meat & Meat Mixtures	
Beef, Pork, Veal, Lamb	160
Turkey, Chicken	165
Fresh Beef, Veal, Lamb	
Medium Rare	145
Medium	160
Well Done	170
Poultry	
Chicken & Turkey, whole	180
Poultry breasts, roast	170
Poultry thighs, wings	180
Duck & Goose	180
Stuffing (cooked alone or in bird)	165
Fresh Pork	
Medium	160
Well Done	170
Ham	
Fresh (raw)	160
Pre-cooked (to reheat)	140
Eggs & Egg Dishes	
Eggs	Cook until yolk & white are firm
Egg dishes	160
Leftovers & Casseroles	
	165

*These temperatures are recommended for consumer cooking. They are not intended for processing, institutional, or foodservice preparation. Food service professionals should consult their state or local food code.

Using the Food Thermometer

Most available food thermometers will give an accurate reading within 2 to 4 °F. The reading will only be correct, however, if the thermometer is placed in the proper location in the food. If not inserted correctly, or if the food thermometer is placed in the wrong area, the reading will not accurately reflect the internal temperature of the food. In general, the food thermometer should be placed in the thickest part of the food, away from bone, fat, or gristle.

Check Manufacturer's Instructions

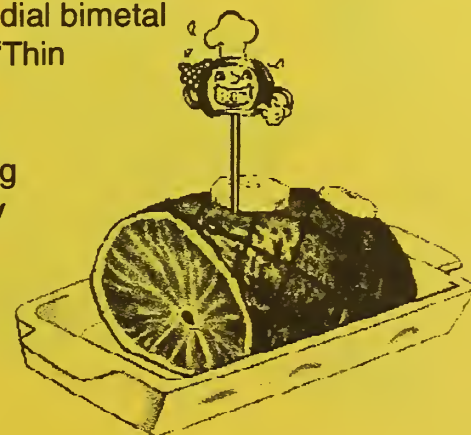
Before using a food thermometer, read the manufacturer's instructions first. The instructions should tell how far the thermometer must be inserted in a food to give an accurate reading. If instructions are not available, check the stem of the food thermometer for an indentation, or “dimple.” This shows one end of the location of the sensing device. Dial thermometers must penetrate about 2 to 3 inches into the food. Most digital thermometers will read the temperature in a small area of the tip.

Where to Place the Food Thermometer

Meat

When taking the temperature of beef, pork, or lamb roasts, the food thermometer should be placed midway in the roast, avoiding the bone. When cooking hamburgers, steaks, or chops, insert a thermistor or thermocouple in the thickest part, away from bone, fat, or gristle. If using a dial bimetal thermometer, read “Thin Foods” below.

When the food being cooked is irregularly shaped, such as with a beef roast, check the temperature in several places.



Poultry

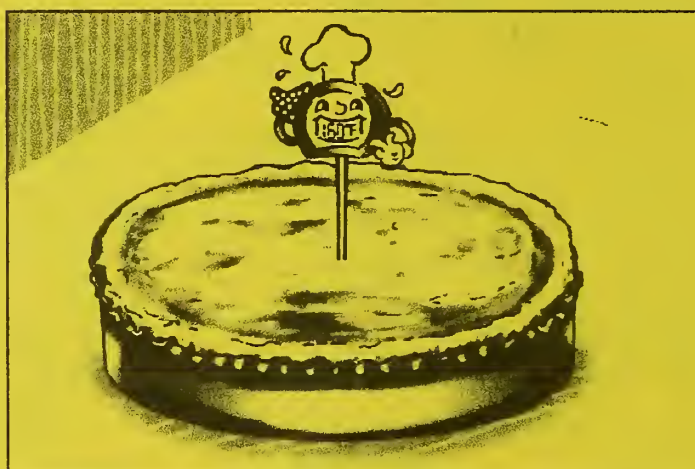
When cooking whole poultry, the food thermometer should be inserted into the thickest part of the thigh (avoiding the bone). If stuffed, the center of the stuffing should be checked after the thigh reads 180 °F (stuffing must reach 165 °F). If cooking poultry parts, insert food thermometer into the thickest area, avoiding the bone. The food thermometer may be inserted sideways if necessary. When the food is irregularly shaped, the temperature should be checked in several places.



To avoid burning fingers, it may be helpful to remove the food from the heat source (if cooking on a grill or in a frying pan) and insert the food thermometer sideways after placing the item on a clean spatula or plate.

Combination Dishes

For casseroles and other combination dishes, place the food thermometer into the thickest portion of the food or the center of the dish. Egg dishes and dishes containing ground meat and poultry should be checked in several places.



Thin Foods

When measuring the temperature of a thin food, such as a hamburger patty, pork chop, or chicken breast, a thermistor or thermocouple food thermometer should be used, if possible.

However, if using an "instant-read" dial bimetallic-coil food thermometer, the probe must be inserted in the side of the food so that entire sensing area (usually 2-3 inches) is positioned through the center of the food.



Thermometer Care

As with any cooking utensil, food thermometers should be washed with hot soapy water. Most thermometers should not be immersed in water. Wash carefully by hand.

Use caution when using a food thermometer. Some models have plastic faces, which can melt if placed too close to heat or dropped in hot liquid.

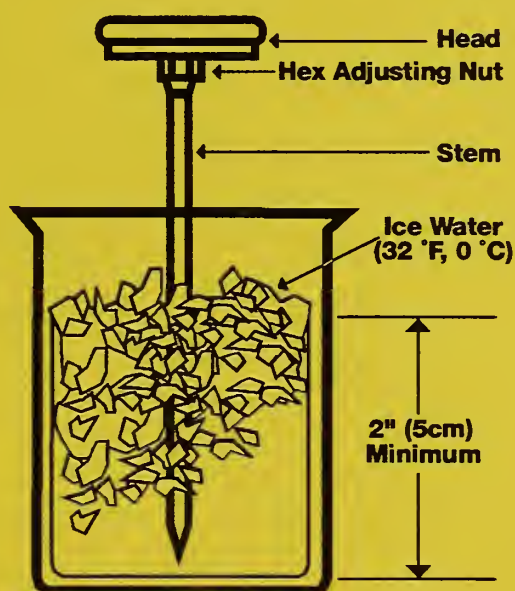
Thermometer probes are sharp and should be stored with the probe in the stem sheath. Some glass thermometers are sensitive to rough handling and should be stored in their packaging for extra protection or in a location where they will not be jostled.

Calibrating a Thermometer

There are two ways to check the accuracy of a food thermometer. One method uses ice water, the other uses boiling water. Many food thermometers have a calibration nut under the dial that can be adjusted. Check the package for instructions.

Ice Water

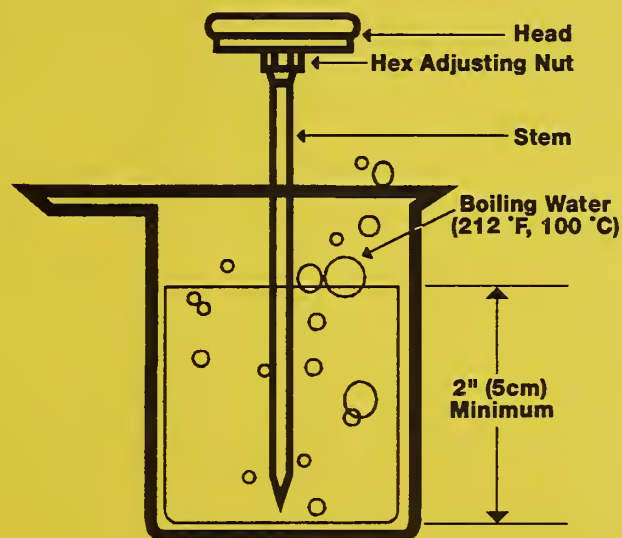
To use the ice water method, fill a large glass with finely crushed ice. Add clean tap water to the top of the ice and stir well. Immerse the food thermometer stem a minimum of 2 inches into the mixture, touching neither the sides nor the bottom of the glass. Wait a minimum of 30 seconds before adjusting. (For ease in handling, the stem of the food thermometer can be placed through the clip section of the stem sheath and, holding the sheath horizontally, lowered into the water.) Without removing the stem from the ice, hold the adjusting nut under the head of the thermometer with a suitable tool and turn the head so the pointer reads 32 °F.



Boiling Water

To use the boiling water method, bring a pot of clean tap water to a full rolling boil. Immerse the stem of a food thermometer in boiling water a minimum of 2 inches and wait at least 30 seconds. (For ease in handling, the stem of the food thermometer can be placed through the clip section of the stem sheath and, holding the sheath horizontally, lowered into the boiling water.) Without removing the stem from the pan, hold the adjusting nut under the head of the food thermometer with a suitable tool and turn the head so the thermometer reads 212 °F.

For true accuracy, distilled water must be used and the atmospheric pressure must be one atmosphere (29.921 inches of mercury). A consumer using tap water in unknown atmospheric conditions would probably not measure water boiling at 212 °F. Most likely it would boil at least 2 °F, and perhaps as much as 5 °F, lower. Remember that water boils at a lower temperature in a high altitude area. Check with the local Cooperative Extension Service or Health Department for the exact temperature of boiling water.





For Additional Information

Even if the food thermometer cannot be calibrated, it should still be checked for accuracy using either method. Any inaccuracies can be taken into consideration when using the food thermometer, or the food thermometer can be replaced. For example, water boils at 212 °F. If the food thermometer reads 214 °F in boiling water, it is reading 2 degrees too high. Therefore 2 degrees must be subtracted from the temperature displayed when taking a reading in food to find out the true temperature. In another example, for safety, ground beef patties must reach 160 °F. If the thermometer is reading 2 degrees too high, 2 degrees would be added to the desired temperature, meaning hamburger patties must be cooked to 162 °F.

For additional food safety information about meat, poultry, or egg products, call the toll-free

USDA Meat and Poultry Hotline

1 (800) 535-4555
(202) 720-3333 (Washington, DC)
TTY: 1 (800) 256-7072

It is staffed by home economists, dietitians and food technologists weekdays year round from 10 a.m. to 4 p.m. Eastern time. An extensive selection of food safety recordings can be heard 24 hours a day using a touch-tone phone.

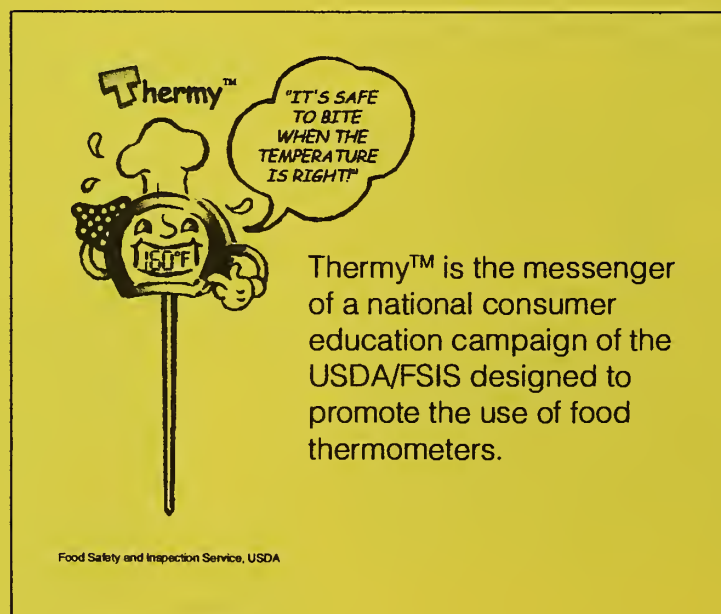
The Meat and Poultry Hotline can be contacted by e-mail at mpholine.fsis@usda.gov.

Information is also available from the FSIS
Web site: www.fsis.usda.gov



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